United States Department of Agriculture
Natural Resources Conservation Service

Virginia Technical Note **Agronomy #7**

"Harvesting, Storing, and Feeding Hay"

May 2001

Hay harvesting, storage, and feeding are important components of any ruminant livestock production system. With recent emphasis on extending the grazing season, it is important to remember that hay cannot be totally eliminated for most producers.

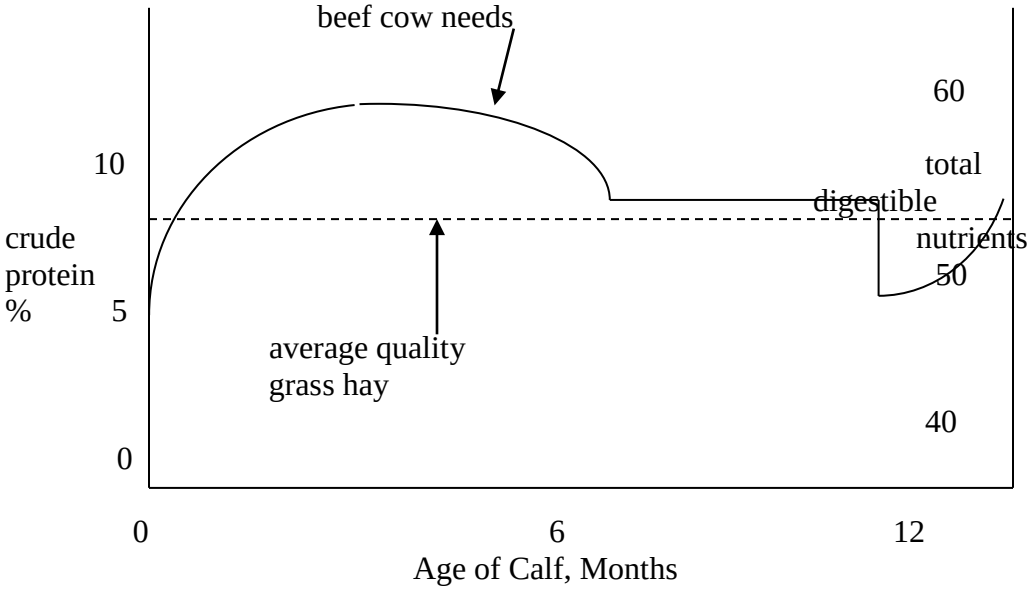
I. HARVESTING HAY

Factors to consider in hay harvest are quality versus quantity, fertility, curing and handling, and weather.

QUALITY VERSUS QUANTITY

The very act of harvesting forages as hay reduces quality even when properly done. Average quality of grass hay cannot supply the nutrient requirements of a beef cow for re-breeding and providing milk for the calf. Consequently, it is very important to harvest forages as hay in such a way as to minimize quality losses. The goal is to harvest forages with sufficient quality to meet the need of the animal consuming it.

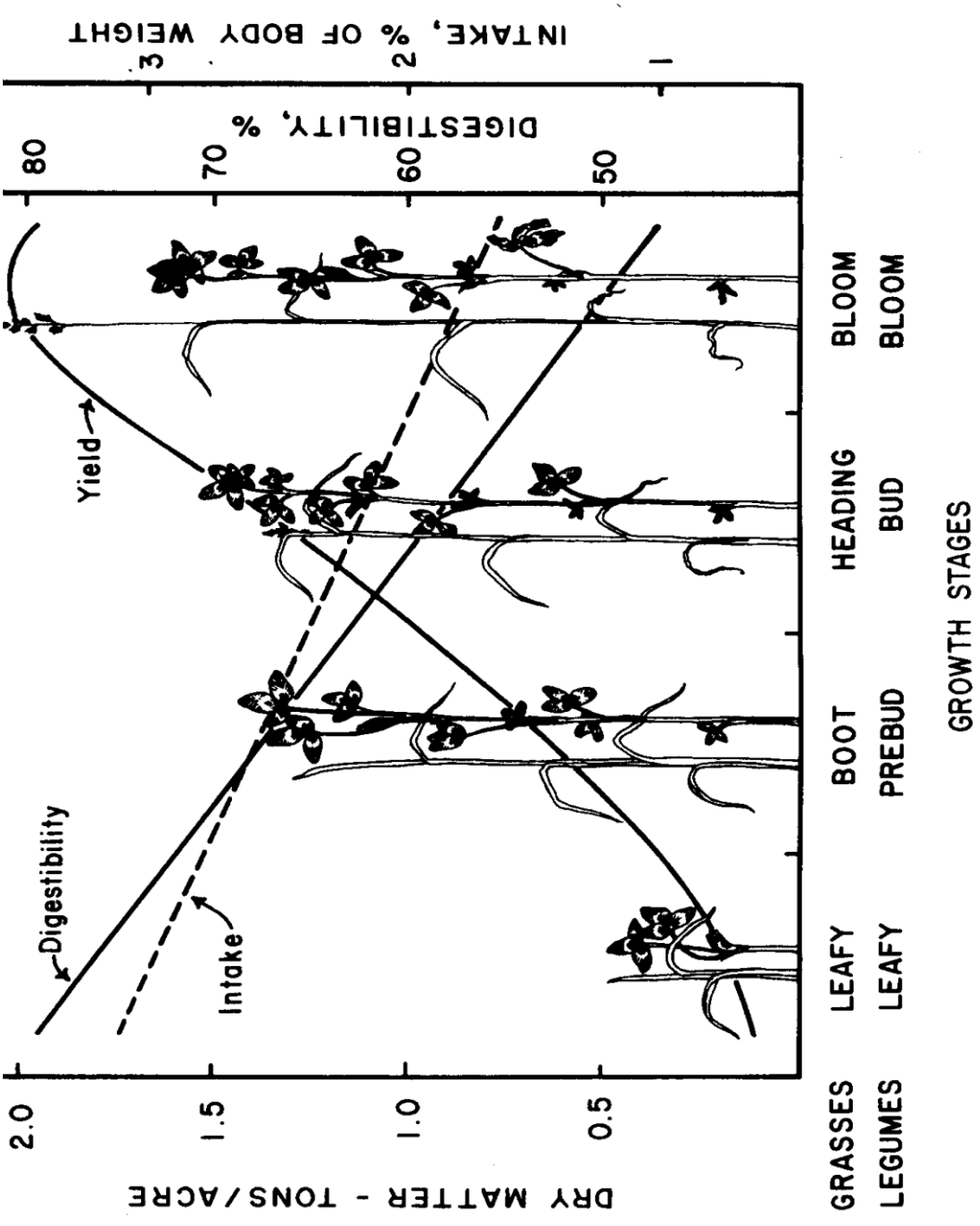
Figure 1. Comparison of Beef Cow Needs and Average Quality Grass Hay. 1/



1/ Source: M. A. McCann, Animal Science Department, University of Georgia in Southern Forages by Don Ball, C. S. Hoveland, and G. D. Lacefield, page 134.

The single most important producer controlled factor influencing hay quality is stage of maturity at harvest. Maturity influences the palatability, crude protein content, and especially the digestible energy level. In general, the best time to harvest for a good yield as well as high energy and crude protein levels is in the early bloom stage for legumes and in the boot stage (just before seedhead emergence) for grasses. Exceptions to this are sericea lespedeza (15 - 18 inches), summer annual grasses (30-40 inches), and hybrid bermudagrass (4 to 5 week intervals or 15 to 18 inches).

Figure 2. Effect of Maturity on Quality and Quantity of Forages. [2/]



2/ Source: Forage-Animal Management Systems by Roy E. Blaser and Colleagues, Virginia Tech Bulletin 86-7, page 13.

Table 1. Recommended Stages to Harvest Various Hay Crops. [3/]

Forage	Time of Harvest
Alfalfa	bud stage for first cutting, 1/10th bloom for second and later cuttings; for spring seeded alfalfa, allow the first cutting to reach mid to full bloom.
Orchardgrass, Timothy, or Tall Fescue	boot to early head stage for first cut, aftermath cuts at 4 to 6 week intervals
Sericea Lespedeza	height of 15 to 18 inches
Oats, Barley, or Wheat	boot to early head stage
Annual Lespedeza	early bloom and before bottom leaves begin to fall
Hybrid Bermudagrass	15 to 18 inch height for first cutting, every 4 to 5 weeks or when 15 inches high thereafter
summer annuals	height of 30 to 40 inches
native warm season perennials	early boot stage at 45 day intervals

3/ Source: J.D. Burns, J.K. Evans and G.D. Lacefield, "Quality Hay Production", Southern Regional Beef Cow Calf Handbook, SR 5004 in Southern Forages by D.M. Ball, C.S. Hoveland, and G.D. Lacefield, page 139.

Table 2. Recommended Stubble Height and Approximate Recovery Period After Hay Harvest. [4/]

Species	Minimum Stubble Height (inches)	Approximate Recovery Period (days)*
Alfalfa	3	20-25
Orchardgrass	3-5	20-30
Tall Fescue	3-4	21-30
Sericea Lespedeza	4-6	18-25
Bermudagrass, Hybrid	3-5	18-28
Annual Lespedeza	2-3	20-30
Switchgrass	≥8-10	30-45
Eastern Gamagrass	≥8-10	28-45
Sorghum-Sudan Hybrids	6-8	21-30
Red Clover	2-3	18-25

* Based on favorable growing conditions for the plant. Longer recovery periods may be needed during stress periods such as extreme heat, cold, wetness, or drought. Shorter cycles may result during favorable growing conditions.

4/ Forage Harvest Management Job Sheet, Georgia NRCS, Revised July 1999

Table 3. Effect of Fescue Hay Maturity on Feed Quality and Animal Gain. [5/]

Stage of harvest	%CP*	DM Intake*	% digestibility	lbs feed: lb gain
late bloom to head (May 3)	13.8	13.0	68	10.1
early bloom (May 14)	10.2	11.7	66	13.5
early milk seed forming (May 25)	7.6	8.6	56	22.5

* crude protein
** dry matter intake
5/ Source: adapted from "Hay as Part of a Cowherd Production System", by Dr. Mark Wahlberg, 1995, VCE pub 400-055.

Table 4. Nutrient Content of Some Hays and Forages Common to Virginia [6/]

Hay	%TDN*	%CP**	%Ca***	%P****
fescue, mature	44	10.8	0.41	0.30
fescue, boot	58	11.5	0.43	0.32
switchgrass	55	7.5	ND*	ND*
orchardgrass, mid bloom	56	9.2	0.26	0.30
corn silage	68	8.2	0.31	0.24
alfalfa haylage	58	17.0	1.74	0.27
fescue-legume, stockpiled	59.1	12.9	ND*	ND*

* ND = not determined

* total digestible nutrients
** crude protein
*** calcium
**** phosphorus
6/ Source: "The Cow-Calf Manager: Winter Feeding and Supplements", Livestock Update, December 1997, Dr. John B. Hall, Virginia Tech

Table 5. Nutritional Needs of Various Beef Animals [7/]

Animal Type	%CP*	%TDN**	%Ca***	%P****
Dry Cow	6.5-9	48-55	0.25	0.15
Lactating Cow	9-12	55-62	0.4	0.25
Stocker	10-13	60-65	0.4	0.2

* crude protein
** total digestible nutrients
*** calcium
**** phosphorus
7/ Source: Nutrient Requirements of Beef Cattle, Seventh Edition; 1996

Note that most of the hay needs to be supplemented with energy, not protein.

In addition to requiring more fuel, time, and labor to store the hay, the further past the optimum stage that hay is harvested, the poorer animal performance will be because of low digestible energy and high fiber. Poor quality hay passes more slowly through the animal's digestive system causing lower intake of low quality hay which further reduces animal performance.

Quality of hay can be improved by renovation with a suitable legume such as red clover. Care must be taken to ensure proper fertility.

FERTILITY AND LIME

Unlike pastures where most of the nutrients are re-deposited onto the field as animal manure, haying removes nutrients from the field and proper fertility management is a must.

Table 6. Nutrient Removal by Hay Crops. [8/]

Forage Crop	Yield tons/acre	N	P	K
		lbs per acre		
alfalfa	5	225	65	225
red clover-orchardgrass	4	170	50	160
fescue	3	120	45	120

8/ Source: "Quality Hay Production", Southern Regional Beef-Cow Handbook, Joe Burns, University of Tennessee et al.

Hay fields should be soil tested annually and the recommendations followed. Grazing paddocks harvested as hay should also be tested.

Grazing paddocks should be tested initially on an annual basis until the desired fertility and pH levels have been reached and every 3 to 4 years thereafter. However, in large fields where nutrient transfer is more likely (animals graze one area and defecate in other areas), soil sampling should be done more frequently.

CURING AND HANDLING

Strive to minimize the time between mowing and baling. Attempt to reduce leaf loss which is especially critical for legumes. The leaf is more delicate and dries faster than the stem. Crushing stems or "conditioning" at time of mowing reduces the differential drying rate between stems and leaves.

The amount of moisture (as a percent) at various harvesting stages is critical to hay quality. Raked or tedded hay should be at 35 to 40% moisture with the hay drying down to 15 to 20% in the windrow. These percent moisture levels help reduce leaf loss. Moisture levels below 15% will result in excessive leaf loss while levels above 20% will result in molded hay and perhaps a fire.

WEATHER

Weather is a risk throughout the haying season but especially for first cuttings. Some producers choose to ensile early hay as haylage or silage. Others use additives which allow hay to be harvested at higher moisture levels to reduce exposure time. Another option is round bale silage. Weather related factors are listed below.

- sunshine - South facing slopes are sunnier which dries hay faster.
- humidity - Sunny warm days lower relative humidity in the air, increasing its ability to absorb water from the forage.
- wind speed - Air movement increases drying rate. Calm air next to the hay can become saturated which slows drying time.
- dews - Dews delay drying time. As the surface temperature drops to the dew-point, water vapor in the air is deposited on the hay. On the next day, energy from the sun must first remove the dew before continuing to dry the hay. Dews are related to the moisture content of the soil.
- moist soil - A rain just before cutting may the slow drying rate by keeping the bottom part of the windrow moist.
- grasses in legumes - The use of grasses in legume hays can aid drying by promoting "fluffiness" in the windrow.

III. STORING HAY

The longer hay is exposed to unfavorable weather conditions, the greater the loss. The moisture content of bales stored outside on the ground without cover may increase up to 120% in the outer 2 to 3 inches which accelerates weathering. In areas of high and/or frequent rainfall, method of storage can make the difference between 5% or more than 50% dry matter loss of hay from weathering.

Table 7. Percentage of the Volume of a Round Bale at Different Depths. [9/]

Depth From Outside of The Bale	Bale Diameter, Feet 4	5	6
	----------%	----------	
2 inches	16	13	11
4 inches	31	25	21
6 inches	44	36	31

9/ Source: Hay As Part of a Cowherd Production System by Mark Wahlberg, VCE pub 400-002, 1995.

Anywhere from 1/3 to nearly 1/2 of the hay in a bale is located in the outside 6 inches, depending on the diameter.

Table 8. Quality Losses During Storage of Round Bale Grass and Grass-Legume Hay. [10/]

Hay	Fraction	CP*	ivddm**	RFV***	$Loss
		% of dry weight			
Grass	unweathered	13.5	58.8	72	-
	weathered	16.4	42.5	75	9.72
Alfalfa	unweathered	14.2	56.5	86	-
	weathered	16.9	34.2	79	22.68

* crude protein
** ivddm - in vitro digestible dry matter - indicates digestibility based on a lab test instead of using live animals. The larger the value, the better.
*** RFV - relative feed value - a measure of forage intake and energy value used to compare different types of hay; the higher the RFV, the higher the quality.
10/ Source: Lechtenberg, V. L., and others; in Proc. Purdue Cow-Calf Research Field Day, West Lafayette, IN., Purdue Univ. Agric. Exp. Stn., April 5, 1995

The percent crude protein increases with weathering due to loss of dry matter.
There is a 28% digestibility loss for grass hay and a 40% loss for alfalfa hay. These huge losses should be considered when deciding on storage method.

Table 9. Cost of Hay Consumed as Affected by Storage and Feeding Losses. [11/]

% loss	Beginning Hay Value, $/Ton 50	70	80
5	52.69	73.68	94.74
10	55.55	77.78	100.00
15	58.87	82.35	105.88
20	62.50	87.50	112.50
25	66.68	93.33	120.00

11/ Source: Minimizing Losses in Hay Storage and Feeding, by Don Ball and others.

Considering the increased haying needs due to dry matter loss, loss of TDN, and reduced palatability, a hay storage facility quickly becomes a viable option for hay stored any length of time.

OUTSIDE HAY STORAGE RECOMMENDATIONS

1. There should be no objects near the hay which will attract lightning.
2. The flat ends of the bales should be butted tightly together.
3. Run the bale rows up and down the slope with a north/south orientation. A southern exposure is best.
4. Bale density should be high to resist water penetration.
5. Protect the top and side from rain with an appropriate cover.
6. Store in bright sunny locations where there are no trees.
7. Avoid hay to soil contact with use of rock, wooden pallets, etc.
8. The round side of the bales should not be touching. Leave at least three feet between rows.
9. Store hay in more than one area to reduce losses by fire. Maintain at least three feet of no vegetation around the bales.

III. FEEDING HAY

Research shows that feeding losses can range from a low of 2 to 6% when great care was exercised and up to as much as 60% where no attempts were made to reduce losses. Feeding losses are caused by trampling, leaf shatter, chemical and physical deterioration, fecal contamination, and refusal. The amount of loss is determined by feeding method, intervals between feedings, amount fed at one time, weather conditions, the number of animals being fed, and forage quality.

Efficient use of hay begins with sorting it by quality so that the proper quality can be matched to animal needs. High quality hay should be fed with care.

Feeding hay on sod offers the advantage of spreading the hay on pastureland rather than concentrating it along a feed bunk or barn. When fed on sod, less is wasted when the ground is dry, well drained, and provides solid footing.

Frequently moving the feeding area spreads manure more uniformly over the fields which improves fertility and minimizes sod damage. The amount of hay fed on sod is utilized better when only one day's worth is fed at a time. All animals should have access to the hay. The least expensive method for spreading hay on sod is to unroll the bale to improve animal access.

The key concepts for feeding hay are:

1. Hay quality should be matched to animal needs.
2. When animals are fed outside, a well-drained site should be selected to reduce feeding losses.
3. Hay stored outside should be fed before hay stored inside. Course, porous hay stored outside should be fed before fine-stemmed, densely baled hay stored outside. Other things being equal, high value hay stored outside
   should be fed before low value hay stored inside.
4. Putting a barrier between animals and hay will help reduce feeding losses. Hay

5. Minimizing the amount of hay to which animals have access at one time will reduce feeding losses.
6. Forcing clean up of hay by animals which have low nutrient requirements before feeding more hay can help reduce hay waste.

SUMMARY

Careful harvesting, storing, and feeding of hay reduces time, labor, and expense. The nutritional needs of livestock are better met and stand condition is maintained or improved.